EMBRYOLOGY.

The Star-fish Larva.—Dr. G. W. Field[1] has published a fully illustrated study of the development of our common star-fish obtained at the U. S. Fish Commission Laboratory, at Woods Holl, Mass. Special attention was directed to the mesenchyme, mesodermal pouches, ciliated bands and watervascular system of the larva with a view to, solving the meaning of the echinoderm larva.

The two symmetrically placed outgrowths of the archenteron acquire connection with the exterior by uniting with two dorsal ectodermal invaginations. These invaginations form two water pores, which are both open for awhile. The one on the right closes up. This double condition is not, as has been maintained, an abnormal condition, but as Professor W. K. Brooks showed, a normal and significant fact.

In discussing the application of these and other facts to the phyllogeny of the Echinoderms, the author holds that–"the Echinoderm ancestor was probably a free-swimming animal, in general characters not far removed from the ancestors of the Turbellarians; a creature with a well-differentiated digestive tract, ciliary locomotor apparatus, excretory system, respiratory surface not localized; cœnogenetrically modified by the acquirement of transparency, long arms and particularly by modification of the external form, by changes in the direction of the ciliated bands, as pointed out by Johannes Müller, into the forms characteristic for the various Echinoderm groups."

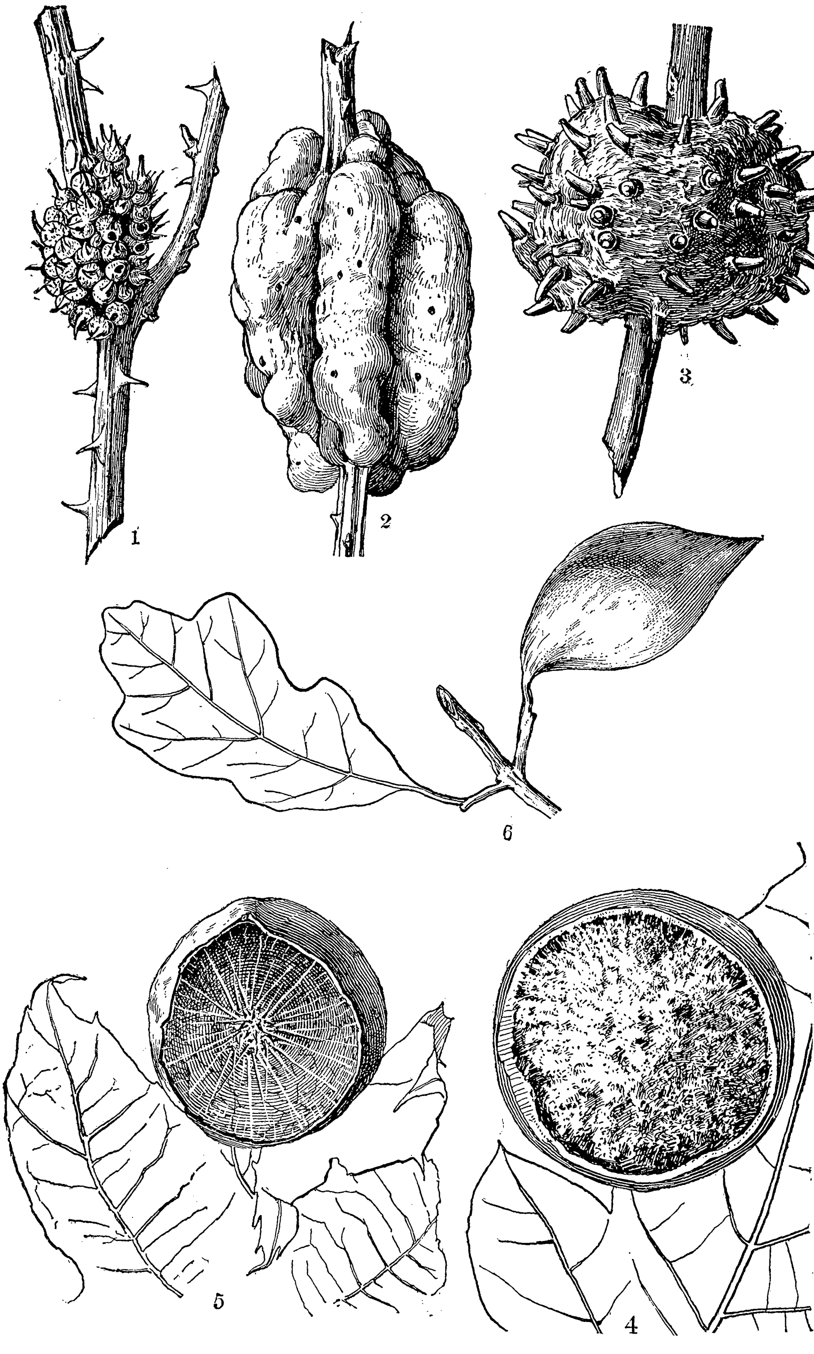
Germ-layers of Amphioxus.[2]—Basilius Lwoff has recently published a short paper in which he gives the results of his observations on the early stages of Amphioxus so far as they differ from those arrived at by Hatschek.

He finds that there is no period of rest at the end of the cleavage, at least as far as the smaller ectoblastic cells are concerned, for they continue to divide frequently. This causes a change in the relative position of the cells at the boundary between the micromeres and macromeres, and results in the passive invagination of the entoblast, ectoblastic cells being the active agents.

[1]Q. J. Mic. Sci. 1892.

[2]Biol. Centralblatt, 12, 1892, pp. 729-744, 8 figs.

PLATE IV.



1. *Diastrophus cuscutæformis* O. S.
2. *Diastrophus nebulosus* O. S.
3. *Andricus cornigerus* O. S.
4. *Amphibolips confluentus* Harr.
5. *Amphibolips inanis* O. S.
6. *Amphibolips ilicifoliæ* Bass.

This multiplication of the entoblastic cells is not equal on all sides, however, but is most frequent on the dorsal side of the invagination; so that the ectoblast becomes invaginated itself at this point and pushing the entoblast before it finally forms the roof of the cavity, while the sides and floor are lined by entoblast. At the same time the margin grows backward and the gastrula mouth gradually closes. In this invagination, then we have two distinct processes: first, the invagination of the entoblastic cells from which the gut is formed, (it is a palingenetic process—the gastrulation); second, the invagination of the dorsal ectoblastic cells; this is to be regarded as a cœnogenetic process, that has nothing to go with gastrulation, but is preparatory to the formation of the chorda and the mesoblast.

Lwoff was unable to find the pole cells of the mesoblast described by Hatschek, and it is interesting to note that more recent observations by E. B. Wilson have had the same result. Lwoff points out, moreover, that even if these cells did exist they could have no connection with the mesoblastic bands; the latter are upon the opposite side from the position assigned to the former.

The multiplication of the cells in the medullary plate causes it to fold inward along the median, and it pushes before it the dorsal wall of the archenteron, leaving a mesoblastic fold on each side. The mesoblast is purely passive in its evagination. The inner half of each fold is composed of ectoblast cells from the roof of the gastrula cavity, and the outer half of entoblast from the side.

The lumen disappears in each mesoblastic segment after it has been constricted off from the general fold. Afterward the true mesoblastic cavity, which is to become the body-cavity, is formed by the separation of the cells in the process of their growth. The body-cavity, therefore, is not a true enterocoel.

The chorda is formed from what is left of the ectoblast in the gastrula cavity, aided, perhaps, by the entoblast at the anterior end. The chordal plate becomes folded outward, and the two sides of the fold are pushed together by the entoblastic cells that at this stage are multiplying rapidly to form the dorsal wall of the gut.

R. P. B.

Epigenesis.—In an interesting review of the history of Evolution versus Epigenesis, Prof. C. Hertwig[3] contributes a few experiments upon the eggs of Triton, to those of Chabry, Fiedler, Driesch and others all tending to overthrow the position occupied by Roux and

[3]Entwichlungs-Theorieen, Berlin, 1892.

Watase regarding the pre-formation and early localization of embryonic organs. While Roux held that the frog's egg is a mosaic in which definite regions must become certain organs, the following experiment of O. Hertwig seems to show that this is unlikely in the related form, the Triton.

When the egg of *Triton palmatus and T. cristatus* taken in May and June 1892 was dividing into two cells, a delicate silk thread was passed around it and drawn together so as to gently squeeze the two first cells somewhat apart. This made the egg somewhat dumb-bell shaped.

Each cell divided and finally an embryo with chorda, somites and nerve tube was formed. As the embryo was not formed so as to lie with its left on one of the hemispheroid parts of the egg and its right upon the other, we may conclude that the first cleavage did not divide the Triton egg so as to separate its right-forming from its left-forming material. The right and left halves are not separated by the first cleavage. In fact in one case the thread separated the head from the tail region.

It is only, the author thinks, by understanding the multiplication of the egg as an organism and the gradual interaction of the numerous cells of any stage that we can arrive at a true conception of the epigenesis-like formation of an embryo.

Form and Chemical Composition.—Curt Hebst[4] of Zurich has published a series of experiments made at Naples and at Triest in the endeavor to determine if the form of organic structures is dependent upon their chemical composition. To this end the eggs of sea urchins, (three species were tried), were reared in sea water to which definite, small amounts of certain salts were added. The salts used were LI Cl, Li Br, LiI, Li NO_3, Li_2 SO_4, Na Br, NaI, Na_2 SO_4, Na NO_3, K Cl, KBr, KI, K NO_3, K_2, SO_4, RhCl, CsCl, Mg SO_4 and Ca Cl_2; the results obtained were certain peculiar forms of larvæ, and the explanation adopted for the results was that the salts acted osmotically, not by altering the chemical constitution of the eggs.

Before speaking of the character of the larvæ reared under these abnormal conditions we will first note a few incidental results sometimes seen. One is that in a number of eggs, two blastulæ were seen inside the egg membrane so that separate twins had been formed from one egg. Again it was sometimes observed that only part of the cleavage cells formed the blastula, the rest remaining as an irregular mass within the

[4]Zeit. f. wiss. zool. 55, Dec., 1892.

same egg membrane. These facts favor the views of Driesch as to the equality of the cleavage cells in the echinoderm. Another peculiar result sometimes followed the addition of salts, namely, the production of twin gastrulæ or plutei (without processes) or even of multiple larvæ all to be regarded in these cases as due to *fusion*. The author entertains no doubt, that by some change in the character of the ectoderm cells the larvæ first adhere and then fuse till there are formed complete twins with two separate mouths, ani and (incomplete) skeletal systems, though but a single body space.

Coming to the main results of the experiments, we find that two peculiar larval forms, the *potassium larvæ and the lithium larvæ* may be formed instead of the normal larvæ when salts of potassium or of lithium are added to sea water.

The potassium larva is simply a pluteus with its normal digestive tract and cilia but without the characteristic pluteus processes or arms and with little or no skeleton. As an example of the amount of material necessary to effect this result may be cited one experiment in which eggs fertilized in normal sea water were put into 860 ccm. sea-water diluted by 140 cm. of 3.7% KNO_3 solution. The larvæ lived for fourteen days but had scarcely any or no skeleton and no arms.

The absence of the skeleton is regarded as the chief thing determining the absence of the pluteus arms; these, it is believed, naturally growing as they are constantly stimulated by the growing skeleton. The cells to form the skeleton may be properly arranged, but do not secrete the lime salts to form the skeleton.

This kind of larva may be formed by other salts than those containing potassium. The lithium larva, however, is formed only by salts containing lithium.

This latter form may be described as two vesicles attached to one another by a hollow stalk. One vesicle has a thicker wall and finer cilia on its outside, the other a thin wall and fewer, longer cilia on its outside. This larva is actually formed by the elongation of a normal blastula followed by a partial abstriction into two vesicular portions.

It is regarded, however, as having the morphological value of a gastrula which has grown in an evaginated form so that the thicker walled vesicle represents the entoderm and the other the ectoderm.

One experiment taken at random will serve to illustrate the amount of salts used; to 1950 ccm. sea-water 50 cm. 3.7% LI Cl solution were added; the characteristic double vesicle larva were formed, but all died on the eighth day.

Most interesting differences obtain amongst the various salts of lithium in the strength of their action. If the eggs of the same sea urchin are treated simultaneously with the various salts we find that at a given time the larvæ were not all equally far advanced, equal amounts of the some salts acting sooner than others in producing the lithium larva, and larger amounts of some salts being necessary to produce the same results as smaller amounts of other salts of lithium.

From a table of such experiment the author concludes that Li Cl, Li NO_3, Li Br, and LiI are less and less active in this order which is also the order of increasing molecular weights. Thus in these experiments where the same per centage of salts was always used the heavy molecules were less numerous and less active; the action of these salts in producing the lithium larva diminishes with the number of molecules used. This rule, however, finds an exception in $Li_2 SO_4$.

In Na Cl, Na NO_3, Na Br, and Na I as well as in K Cl, K NO_3, K Br and KI we find again the same rule; the larger number of molecules being most efficient in forming the so-called potassium larvæ, and so on down to the heaviest. The results hold only for salts of the same metal.

Now since it is known from the work of H. De Vries and others that osmotic pressure is associated with the number of molecules in a given volume, increasing with diminishing molecular weight we find so close a similarity between the effects of salt upon larvæ and their osmotic action, that we may conclude, the author thinks, that these effects are due to their osmotic action.

Thus the potassium larva is to be regarded as the result of disturbing those chemical processes which would have normally formed a lime skeleton, and this disturbance is by the removal of water osmotically. Again the lithium larva may be regarded as due to some peculiar impermeability of sea urchin larval cells toward salt of lithium; this produces strong osmotic pressure. The pressure is not regarded as working in a gross mechanical way, but rather as a stimulus that causes the larval cells to grow in an abnormal way.

Though this explanation leaves no room for chemical changes as a source of change of form in these echinoderm experiments, yet the author is inclined to think that in some cases, as in the formation of galls, chemical changes of the protoplasm may cause the changed form that results.

The application of this study in experimental embryology is that the normal course of ontogeny is dependent upon the conditions of osmotic pressure within and without the body.